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INNOVATION MANAGEMENT ON THE WAY TO BUSINESS EXCELLENCE

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Abstract. *The current conditions of the global economy have caused innovative changes to be the main condition for a good, sustainable, competitive business of the organization. The solution to the problem can be seen in innovation management, of course with information technology. The goal of this work is the development of innovation with practical software solutions through the innovation management process, i.e. increasing business excellence in the organization. Researchers in organizations use original experience in the implementation of developed software solutions in the field of document management and business innovation. In recent times with globalization and the technological revolution, knowledge has become a key resource for the economic growth and development of nations. Accordingly, the improvement of innovation has become a key condition for the sustainable development and competitiveness of organizations on the local and international market. The results of the conducted research are presented through author-developed programs for statistical data processing and for assessing economic sustainability and achieved business excellence (based on the EFQM 2013 methodology).*

Keywords: *Management system, quality, innovation, document management*

1. Introduction

In order for the economy to progress, strategic investments for the development of technology that lead us to innovation must be increased. Knowledge and innovation have the greatest importance in the development of society, since the very beginnings of human civilization. The assessment of economic sustainability is a special form that expresses the overall performance of the business. Only with a fundamental concept can the company achieve good results and show business excellence with the maximum involvement of all interested parties, with knowledge management.

Globalization and the technological revolution with knowledge represent a key resource for the economic growth and development of nations. Accordingly, the improvement of innovation has become a key condition for the sustainability and competitiveness of organizations on the local and international market. In the modern economy, small and medium-sized organizations play a significant role in creating the gross domestic product of individual countries. Changes in the business environment have reduced the structural disadvantages of small and medium-sized enterprises, due to the small business volume.

The end of the last century and the beginning of this century are marked by general globalization around the world. The increase in industrial production and the devastation of the human environment created an obligation for numerous national and international institutions to

introduce new approaches for restructuring economic flows. The need to organize sustainable development with intergenerational solidarity, which implies the responsible use of natural resource potential, is increasingly emerging.

Skilled managers transform their knowledge through ideas into a new product and service with added value as part of research activities. The innovation process must be well planned and clearly oriented towards obtaining a positive final result. Large investments in research and development as well as other elements of the innovation process do not necessarily result in successful innovations. Innovation efforts and activities can be misdirected. There is a possibility that good ideas will not be implemented due to the creation of a bottleneck in some part of the innovation process.

The innovation process first requires an idea, with a focus on the conceptual solution, innovation modeling (invention), evaluation of alternatives, decision-making and innovation implementation. Rapid changes, great competitive advantages, increasing expenditures for research work, influence the small economy to search for new, more open types of innovation, as well as to cooperate with external partners and develop new products or services on the market before its competitors. The main concern of this economy is to make the best use of the internal possibilities of research and development in order to maximize the advantage through the model of open innovation.

A successful open innovation strategy for small and medium-sized enterprises must use the internal innovation potential for good development innovation solutions. On the other hand, there are also problems that limit the use of the open investment model in small and medium-sized enterprises. This often does not allow an aggressive market presence at the right time and with the right product.

1.2 Methodological approach

Research objective. One of the possible approaches to solving the problem of determining and activating the innovative potential of small and medium-sized enterprises assumes the development of a model for the management of quality system documentation. However, this model requires expansion to a level that will represent a prototype platform for initiating, modeling and testing business process innovations. Therefore, the model must provide data on the success of the tested processes, as well as a methodology for their transition from a successful prototype to an operational version.

The work shows, through the author's conceptual model and a practical software solution in the food industry, the process of modeling, making and implementing a possible solution to this problem. Also, the conceived model provides a solution for efficient, effective and sustainable implementation in a real business environment:

- tools for training staff and management to get involved as bearers of business system redesign according to the new Service Oriented Architecture (SOA)/Business Activity Monitoring (BAM)/Complenx Event Processing (CEP) paradigm, with the help of benefits obtained from the implementation of ISO 9000 + Business Excellence (BE);
- the logic of the new paradigm into existing business solutions and its prototype testing by staff and management, with the support of Information Technology (IT) staff and consultants;
- new and changed IT solutions that are designed according to the new paradigm, but also logically tested through prototype application.

This would test the potential of a synergistic innovative effect for the creation of benefits obtained by the complementary application of Quality Management System (QMS) and Information Technology (IT) to the business system (enterprise). and with the help of Documentation of Quality Management System (DQMS) as a catalyst for innovating business processes.

Theoretical foundations of research. Innovations, knowledge and entrepreneurship represent a key determinant of economic growth and improving the competitiveness of companies and countries [1]. Enterprise innovation means the ability to produce and commercially valorize goods and services based on the use of new knowledge and skills [2]. Improving innovation is a key condition for the economic progress of countries, while innovation policy is the most important instrument of long-term economic development strategies and improving the competitiveness of countries in the knowledge-driven global economy [3]. In today's conditions, it is possible to ensure a satisfactory development performance of the company, as well as the respectable competitive position of the country on the world market, only under the assumption of satisfactory innovativeness of its economy.

A good example of BAM/CEP implementation for HACCP purposes is the AliFarm dairy farm management software solution of the Israeli company AfiMilk [4]. Although it is not structured as SOA architecture, the program creates in real time a cloud of events, compares it with historical data and, based on predefined scenarios, predicts complex events (such as the occurrence of mastitis in the throat) and automatically initiates corrective action to treat the throat and informs the farm manager.

Business excellence is a creative framework that naturally follows the implementation of the ISO 9000 series quality standards [5]. Business excellence is a term that implies the systematic use of the basic principles and tools of quality management with the aim of improving organizational performance. The concretization of this concept in practice is the European Foundation For Quality Management (EFQM) model of business excellence as the most popular quality tool in Europe. The model is based on nine basic elements, which at the first level are divided into two groups: a) criteria that enable the realization of results and b) results.

a) The criteria that enable the realization of results are:

K1. Leadership,

K2. Strategy

K3. People (directly or indirectly involved in the functioning of the organization) K4. Partnership and resources

K5. processes, products and services

b) The group of results includes results related to:

R1. Customers

R2. People (directly or indirectly involved in the functioning of the organization)

R3. Social community

R4. Business

The model is dynamic in nature and is based on learning, creativity and innovation that improve the first five criteria, which automatically affects the improvement of results. By implementing this model in practice, companies achieve the following goals:

- Permanent creation of added value for their customers and clients by understanding, predicting and satisfying their needs and expectations.
- Constantly improving their own performance, thereby positively influencing their

environment, creating a sustainable future for the environment by improving its economic, ecological and social conditions.

- Improvement of organizational potential and timely response to changes within or outside the boundaries of the business system.
- Market growth using the creativity and innovation of all employees.
- Creating leadership with a vision that shapes the future of the organization and guides it towards the realization of that vision.
- Ability to identify and respond efficiently and effectively to both opportunities and threats.
- Valuing employees and aligning individual progress with organizational growth.
- Effectiveness in achieving long-term and short-term plans with maximum efficiency in the use of own resources.

From the above, it can be concluded that innovation is one of the key assumptions for the realization of the model of business excellence [6]. This is the reason that the central topic addressed in this paper belongs to the innovation management process. In this paper, an original methodology, a new model and a software solution for expanding the Quality Document Management System (QDMS) domain are proposed in order to increase the innovative capacity of SMEs with the aim of reaching a higher level of business excellence.

Basic hypotheses. The development of the approach to designing a permanent model integrated into the process with the support of the innovation management process proposed in this paper is based on theoretical assumptions and practical achievements of modern cybernetics, decision theory, production management, industrial, information and software engineering. Based on that, the following hypotheses are defined in the paper based on modern paradigms in the field of management and information technologies:

- H1: By applying the proposed model, it is possible to reduce the time that passes from the idea to the implementation of the innovation (incubation period).
- H2: By applying the proposed model, it is possible to increase the number of initiated, and therefore implemented, innovations and thus increase the efficiency of the innovation process.
- H3: By applying the proposed model, it is possible to raise the level of business excellence (measured according to the EFQM methodology), which shows the growth of the effectiveness of the innovation process.

Methods, models, techniques, approaches and tools applied in research. In the research, which precedes the implementation of the proposed approach to designing an original model for dynamic evaluation and support for the innovation management process, the theories of system-oriented scientific disciplines of knowledge management will be used. The scientific basis should be provided by the methods on which the model will be developed. In addition to the general scientific methods that will be applied, including: the method of analysis and synthesis, the method of abstraction and concretization, the method of generalization and specialization, the method of description, etc., certain models, techniques, approaches, concepts and tools will be applied within the framework of individual methodology.

Expected results. In accordance with the objectives of the research and the basic scientific hypotheses set in this work, relevant theoretical, methodological and, above all, practical results are expected.

2. The Function of the Quality Concept Leads To Business Excellence

Quality is the result of a carefully constructed environmental culture. It must be the fabric from which the organization is sewn, not a button sewn onto the fabric. Philip B. Crosby [7]. In modern business conditions, quality is considered a factor in the survival and development of every company, which significantly determines competitive ability, success and vitality of the economy as a whole. The vision of the future consists in the implementation of quality. But there are certain changes taking place that arise from the shift from the concept of product quality to quality management. Innovation is a key assumption for the functioning of organizations in the 21st century. But in order to know how to build an innovative organization, companies must first "climb on the shoulders of the great" [8]. The ISO 9000 series of standards defines the requirements of quality management as fundamental conditions for achieving the best practices of successful companies while continuously approaching the goals of business excellence [5].

Evolution of the quality management system. Quality management includes measures for organization, planning, control and monitoring of numerous aspects relevant to quality. The evolution of the quality management system is continuously controlled by stages: controlling and determining quality control, quality assurance, quality management (ISO 9000), Total Quality Management (TQM) and, in modern conditions, the Business Excellence (BE) phase, which at the highest level strives for the concept of quality-of-life management (QoL) [9]. The QoL phase is the most comprehensive and consistent approach to quality management and represents the last instance in the evolution of quality management.

The first phase, the phase of control and testing, has its roots already at the end of the 19th century thanks primarily to the affirmation of mass production. The first forms of industrial quality control appear in the sense of articulated, primarily production activity.

Phase II – Quality Control. The result was an orientation towards meeting the required quantities of goods on the market. At this stage, the primary activity within quality management was product control.

Phase III - Quality Assurance. The increase in production capacity and produced quantities due to technological progress has led to a balance between supply and demand in terms of quantities. At the moment of equilibrium, the customer gets the opportunity to choose the goods, that is, to choose the producer. The customer's ability to choose also initiates the possibility to set certain requirements to the manufacturer. The requirements are defined in the form of statistical indicators of the quality of deliveries Acceptable Quality Level (AQL). The practical application of this new approach to quality comes to full expression with the introduction of the ISO 9000 series standard in the next phase.

Phase IV - Quality Management. The tightening of competition among suppliers positions the customer to be able to demand the product without error. The customer determines what the quality of the product is, and requires that it be ensured by statistical methods (testing batches, etc.). Furthermore, the customer insists on the supplier's quality system, so that there are no errors in production and delivery. Large users (automotive industry, manufacturers of electronic parts, etc.) in this period began to introduce predefined quality assurance systems of suppliers, which ensured their verification in a certain way [10].

Phase V - Total Quality Management (TQM) phase. As product quality becomes the default condition of competitiveness, the market differentiation of companies shifts towards services [11]. Almost every production activity is accompanied by services. In the perception of product quality by users, service has a very important place.

Phase VI - Phase of QoL and Business Excellence. The phase of QoL (quality of life) and business excellence as a creative framework represents the social aspect of quality. That is, that the process activities of each company produce products that are healthy for people, as well as the environment, suitable for customers and saving natural resources. Business excellence is based on the concept of sustainable competitiveness that combines the economic, environmental and social sustainability of the system in a global context [12].

Also, the globalization of the market leads to an increasing role of achieved business excellence and its verification by comparing business processes and performance indicators with the best business practices at the global level (Benchmarking).

3. Development of a Quality Model for the Evaluation of Innovations

This part explains the methodological and practical application of the idea of possible synergistic effect through the interaction of Quality Assurance (QA) and Information Technology (IT) systems in small and medium-sized enterprises that do not have significant, first of all, human resources such as large organizations. The backbone is the potential role of QMS documentation as a catalyst for the interaction of QA and IT systems in the process of modeling and applying new information paradigms.

The ultimate goal is to increase the innovative capacity of the business system as a determinant of business excellence. The methodology is accompanied by the analysis of a case study based on practical application in the food industry, in the concrete process of collecting, analyzing and receiving raw milk in the dairy.

3.1 Service Oriented Architecture (SOA)

Event Driven (ED), which already has a great influence in the business environment, but the problem of continuous recognition and analysis of important data, and that in real time, prevents sufficient agility and ability of companies to make timely and correct business decisions. Therefore, it is vital that Business Process Management (BPM)/Enterprise Resource Planning (ERP)/Customer Relationship Management (CRM) solutions based on SOA architecture continuously and in real time monitor the flow of events in the process [13], perform their processing (transformation , filtering and, according to pre-defined patterns of events, noticing the occurrence of scenarios of importance. Based on this, it provides: a) automatic reaction and/or notification of actors in the system, b) initiates adjustment of business activities/processes, and c) initiates timely preventive/corrective actions. In order to make this possible, it is necessary to implement BAM/CEP within the organization's IT system, which is based on the Event Driven Architecture (EDA) paradigm.

Service Oriented Architecture (SOA) represents an effective technology for the integration of distributed information systems in complex business environments. SOA is based on web service technology where, by adapting the request/response mechanism, the user's request is forwarded to one of the services provided by the distributed service provider, which after processing the request returns the response to the user. However, in business systems with a high level of distribution of functions, such pulling services based on request/response mechanisms do not provide a sufficiently efficient and flexible solution, because the business system (enterprise) changes at a high speed in order to adapt to the diverse requirements of the environment. Such a dynamic imposes an event-driven (ED) approach as an additional complement to the SOA paradigm, as it enables a more natural distributed application of services through the Publish/Subscribe mechanism.

The main advantage of the ED paradigm is that it formalizes a cloud of business events with different levels of semantic capacity, which represent a very important resource in the process of managing knowledge flows and developing the innovative character of the entire organization.

QDMS as a prototype platform and catalyst for the ED paradigm. Application services, available from providers, map business services in a process-modeled business environment, which is described in detail by the QMS documentation [14]. In order for the mapping to be effective, it is necessary for the documentation to faithfully reflect the business system and all its changes, as well as for it to have a mechanism for prototypical testing of changes through the records of the documentation system. This raises the quality of the documentation system to the level of a mechanism for iterative innovation of the system's business performance.

All this implies strong requirements for the implementation of a QDMS based on a process approach. QDMS traditionally has to provide QMS documentation management. The dominant paradigm of the culture of education and work is based on rewarding success and punishing mistakes (obedience is valued more than curiosity). This encourages the monitoring of routine algorithms during the execution of activities, which is the essence of standardization culture [15].

However, innovation requires imagination, curiosity, invention, learning through trial, error, failure and retry. There must be a space where new ideas can be tested through prototype application and people must be motivated to use that space and feel comfortable in it.

Hazard Analysis And Critical Control Points (HACCP) and ED/BAM/CEP principles. In a concrete practical example, the methodology focuses on a case study from the food industry (specifically the industry of production and processing of milk and dairy products) where the mandatory complement of the QA system is ISO 22000/HACCP (in addition to the generic ISO 9001 complement of the QA system which is basic and universal), but the methodology is fully applicable to organizations from any other field of business.

In that case, as a natural solution to the IT paradigm that would successfully map the QA paradigm in the food industry (eg ISO 9000 + HACCP) the application of event-driven architectures (BPM/SOA/ED/BAM/CEP). The basic principles of HACCP and ED systems are given and mapped in the following table 1.

The case study that will be presented in the next part deals with the situation when HACCP is the dominant component of the QA system, but the mapping of ED principles is also applicable with the QA system (ISO 9001:2008).

Table 1. Mapping of HACCP and ED principles

HACCP principles **Source:** Mortimore, S., & Wallace, C. (2013). HACCP: A practical approach. Springer	**ED/BAM/CEP principles** **Source:** Luckham, D. (2008). A Brief Overview of the Concepts of CEP1.
Hazard analysis (flow diagram for each step, recognize the hazard, make an inventory and determine control measures)	Event identification (an event is an object that represents or records an activity that occurs, or abstracted as an event)
Identifying critical control points – CPP (decision tree)	Observing event scenarios (an event scenario can be a time schedule or a causal relationship between patterns of events)
Determining critical limits (ensuring	**Event scenario constraints** (scenarios that are not

control of each critical control point)	realistically expected in the organization's operations)
Establishing a monitoring system - monitoring	**Activating measures by the occurrence of event scenarios** (using event scenarios to initiate reactive measures, then when these scenarios occur)
Establishing corrective measures that should be taken when monitoring indicates that an individual CCP is not under control	
Establishing verification procedures to confirm that the HACCP system is effective (critical audit and tests)	Event cloud formation (monitoring of historical event data and establishment of a hierarchical map of abstractions)
	Event scenario abstraction (an event is an event scenario abstraction if it summarizes, represents, or denotes an observed set of events)
	Hierarchy of events (the hierarchy of events defines a set of activity levels and a set of rules for calculating events at each level of abstraction of the event scenario from its subordinate levels)
Establishing documentation related to all procedures and records in accordance with these principles and their application (documentation management).	**Event cloud formation** (monitoring of historical event data and establishment of a hierarchical map of abstractions)

A good example of the application of BAM/CEP implementation for the needs of HACCP is the software solution for managing the dairy cow farm AfiFarm of the Israeli company AfiMilk [4]. Although it is not structured as a SOA architecture, the program creates all events in real time, compares them with historical data and, based on predefined scenarios, predicts complex events (such as the occurrence of mastitis in the throat) and automatically initiates corrective action to treat the throat and informs the farm manager.

The problems pointed to by previous research, implementation of BAM/CEP in environments with a HACCP system, refer to the technical side such as: the capacity of events that the CEP system can process, the number of lost events, the system's agility to changes in real time, the system's ability to quickly react to a problem and return to stable state (resilient), capacities for event processing and analysis, and optimization of the event processing process. This approach would activate the potential of the synergistic effect of the complementary application of QA and IT systems to the business system (enterprise), and with the help of QDMS as a catalyst for the interaction of these two systems.

Approach methodology. During the completion of the organization's business processes, it is necessary that there is a continuous cycle of adaptation and innovation of the business system, which is formally defined through policy and quality goals. The implementation of BAM/CEP/ED architecture should be seen as infrastructural innovation and not as the ultimate replacement of the existing IT system. The proposed methodological cycle of process adaptation and innovation is structurally divided into five phases that take place in parallel with the previously explained cycle of managing knowledge flows, as well as the cycle of managing documentation as the physical carrier of that knowledge. In order to apply the developed methodology for business process innovation, it is necessary for the organization to apply or during process innovation implement IT components (extended domain QDMS, ED/BAM/CEP components and business applications that support the process being innovated).

Defining the focus of process innovation. Before starting to implement process innovation into the existing IT system, it is necessary to define a procedure and provide tools

for scanning and analyzing existing event data as a valuable corporate resource from which, colloquially speaking, we read the history of the business system. This phase can be divided into three steps:

1. selection of key process parameters and sub-processes (separating the significant minority from the insignificant majority - overcoming IT blindness [16], and connecting them with the events that emit them and the events that consume them (events in processes and their interactions in the system);
2. iterative abstraction of low-semantic events into high-semantic events (data filtering, discovery of patterns of event scenarios - patterns of events, as well as data derivation represents iterative drill-down cycles in which the capacity of abstraction increases and thereby raises the semantic value of complex events that are detected after each cycle);
3. defining priorities for implementation and measurable parameters for determining the success of the process in accordance with the set business goals.

The abstraction process is iterative. Its mathematical description is given in Table 2.

Table 2. Display of event processing function from lower to higher semantic level

$I_n = f_n\left(\sum_{x_n}^{1} D_n\right)$	
$f_n = f_{nF} \cdot f_{nM} \cdot f_{nD}$	
$I_n = D_{n+1};$	
Where are:	
n	level of abstraction (levels of abstraction are not unambiguously determined but depend on the availability and level of accuracy of data on events at a given time and in a given environment, i.e. on the context in which the events are located)
$\mathbf{D_n}$	event data of the n-th level of abstraction (does not have semantics at that level)
$\mathbf{I_n}$	information about events of the n-th level of abstraction (have semantics at that level)
f_n	aggregate event data processing function
f_{nF}	function of filtering data about to events at the n-th level of abstraction,
f_{nM}	the function of detecting the scheme (pattern) of event data at the n-th level of abstraction
f_{nD}	the function of deriving a new event based on the event data at the n-th level of abstraction

Modeling of process innovation prototypes. As the QA system (in our example ISO9000+HACCP) implies complete documentation of the system, the modeling of acquisition, monitoring and event processing can be carried out through the processes of: 1) documentation management and 2) record management of this system, adhering to all the intended activities of these two processes. Table 3. shows the documentation layers of the management system and the ED-based system that indicate a certain degree of parallelism and give a recommendation for mapping the documentation and the ED-based application in a conceptual sense.

Additional problems in this stage of process innovation modeling are different languages of communication, i.e. vocabularies, syntax and semantics of IT and QA systems, as well as the absence of standard definitions and building blocks for Event Driven Based System (EDBS). Therefore, in the entire methodological process, it is recommended to adopt and apply the standard ISO 9000 dictionary as universal for all systems.

Table 3. Parallel view of EDB application layers and QMS documentation

Layer	**Business solution as an application based on event management** (EDB systems aplication)	**Documentation system supported by QDMS**
1	Language layer	Standard operating procedures layer
2	Execution layer	Specific work instructions layer
3	Communication layer	Forms layer (forms) with a defined time and functional schedule
4	Data download and creation layer	Records layer (filled forms, drawings, databases, etc.)

Source: Voisard, A., & Ziekow, H. (2011). Architect: A layered framework for classifying technologies of event-based systems. Information Systems, 36(6), 937-957.

Implementation and application of process innovation. As it is not realistic to expect a sudden transition of the company's IT system to BAM/CEP/SOA solutions, after prototype testing, Successfully validated scenarios would be implemented in existing IT solutions (applications, modules), coming as close as possible (as much as the adaptation of existing modules allows in terms of expediency) to the BAM/CEP paradigm, including the information push approach (solving the question: Where and when is information needed? ; How to get information at the place and time when it is needed?; How to prioritize information in accordance with its importance?); Users get the possibility of subscribing to available and desired data about events (the source of the event can be automatic, for example, laboratory software, business module, hardware sensor, but also a person) that happen according to interesting scenarios for them, and the system would send them data when the given scenario happens (here the scenario is actually a prediction of a complex event).

The implementation of the BAM/CEP paradigm should be seen as a way to expand the scope of existing applications in a flexible and non-invasive way. Instead of comprehensive interventions on existing applications, we should strive to add functionality that enables the broadcasting and consumption of events. In this way, the intermediate ED layer for event processing can be separated and thereby enable the rapid adaptation of existing solutions to the new business requirements of the system (the aspiration is that the application users themselves perform iterative adaptation during use).

Monitoring, analysis and optimization of process innovation. During the exploitation of the ED module, it is necessary to enable continuous monitoring and analysis of the set process parameters and thereby monitor the success and expediency of the implementation in practice. In accordance with the ED paradigm, process parameters are event data to which different business functions subscribe and, based on the analysis of that data, change, cancel or define new business scenarios.

This phase includes the intensive use of software tools for monitoring, statistical processing (pareto diagrams, histograms, control charts, correlation diagrams) as well as predefined and ad-hoc (custom) data analysis of events in the system. On the basis of these analyses, the semantic capacity is raised to the level required to start a new cycle of adaptation of business processes with the aim of their continuous improvement and innovation.

3.2 An example of the application of process innovation in practice - a case study

The authors applied process innovation using the previously described methodology in a company engaged in the production of dairy products, and its structure belongs to small and medium enterprises.

The practical application of the methodology is focused on the example of the innovation of the business process of collecting, analyzing and receiving raw milk as one of the key processes/sub-processes of processing and production of milk and dairy products. Dairy production belongs to the food industry sector where there is a trend of implementing integrated management systems (eg ISO 9000 + HACCP), which makes it a good candidate for ED remodeling of IT systems. The dairy that is the subject of the case study had already implemented:

1. Integrated quality management system - QMS.
2. IT system in the segment of composite applications with a low level of interoperability and a high level of data redundancy, which included:
    - ssQDMS for quality management system documentation management – QDoc, which was implemented in parallel with the QA system, but was subsequently partially extended to the domain of design management. During the project, an additional module was developed in QDoc for managing QMS records, which included: a) pseudo-application layer and b) ED layer.
    - data mining module for the analysis of existing data in the IT system – the QProMng application module adapted to the specific needs of a large number of dairies for which it was originally designed and developed,
    - an application for managing the collection business process, analysis and reception of raw milk - QLabMlek as a business application which, in the process of innovating the process, is functionally expanded by applying the ED/BAM/CEP paradigm (the ED layer of the application is implemented).

The software programs listed above are intended for general support to employees and consultants during QMS implementation, but are modified during process innovation based on the analysis of user requirements.

In the first phase of defining the focus of process innovation and key parameters, the QMS documentation for the selected process - Collection, analysis and reception of raw milk was used as a starting resource: 1) Procedure, 2) Quality plan, 3) HACCP process plan, 4) Process list and 5) Accompanying forms. As HACCP requirements are naturally mapped into the ED paradigm, from the documentation, we came to the initial model of the event processing network which shows. During the project, the model was corrected and optimized through an iterative drill-down process of historical data from the existing IT system.

After defining the framework in which the modeling of the BAM/CEP paradigm moves, the above-mentioned two author's application solutions (QDoc and QProMng) provided a system that enabled employees in the organization to implement process innovations and their dynamic evaluation according to the previously defined methodology.

1) The first step. In order to define the focus of process innovation, a tool for monitoring, scanning and analyzing data from the event cloud (drill down/data mining) was used, which iteratively abstracts low-semantic event data into high-semantic information. In this way, users get the opportunity to: a) choose databases, b) combine a number of heterogeneous databases through queries, and c) analyze focused data. Thus, they detect patterns of events of interest for

the performance of business processes and define the focus of innovation.

2) Second step. In the innovation modeling phase, it is possible to create and propose draft forms that employees recognize as occasionally recurring scenarios of events important for making business decisions. Users define these scenarios as suitable candidates for process innovation.

The implemented QDMS supports employee collaboration in focusing innovation in order to further optimize proposed design patterns through teamwork. This provides a channel that promotes the flow of exchange and codification of employees' knowledge and reviews the innovation. By applying the basic functionalities of the implemented QDMS, the draft form becomes a system document and is approved for use by the authorized function. Collaboration on the application of the form in practice finalizes the process innovation modeling phase.

3) The third step. The phase of the zero implementation of the innovation requires the definition of the chronology hodogram and the functions that participate in the application of the form with different roles in the scenario in which the application of the form takes place (launch, filling, approval, distribution, use, initiation of action, etc.). This defines the application rules of process innovation in the pseudo-application layer of QDMS.

Defining the functions but also specific persons who have certain roles in the application of records is (according to the author's experience) of key importance for zero implementation of process innovation. For this reason, it is possible to define the priorities of employees with the same functions. Priorities are determined by analyzing the files of employees in terms of their formal and informal competencies as well as the position of the evaluation of individual persons (according to the set criteria defined by the human resources management process) in relation to the average of the organization.

The application of forms, records and accompanying documentation through the pseudo-application and ED layer enables the acquisition, monitoring and processing of generated events, which results in the initiation of previously defined triggers for initiating business decisions. In this way, records management through QDMS forms a prototype platform for zero realization, verification and validation of process innovation.

4) The fourth step. The implementation phase of the process innovation is done after its validation in QDMS. The implementation of the process innovation in the specific case study was carried out as an infrastructural superstructure (ED layer of the QlabMlek business application) which includes:

- event registration services (event service notifications) with parameters for publishing event data,
- a mechanism for subscribing business functions to selected event data according to the given scenario (pattern) for the problems of receiving raw milk in the dairy,
- defining the event trigger as a reaction to the occurrence of the given scenarios (pattern).

From a technological point of view, the solution was realized with VBA/JetDB/SMTP technologies and protocols, in the pilot phase of the implementation of process innovation, in the existing IT infrastructure. It is a non-scalable technology, but it proved to be very applicable in the specific case with 20 or less, competitive users (which is the case with most SMEs). Also, the solution is fully applicable to organizations with a very limited IT infrastructure. The implementation of process innovation is possible without a dedicated server or on a server with an open source operating system, which is a common characteristic of SMEs. G

5) Fifth step. The phase of monitoring, analysis and optimization of the process innovation was realized with author's software tools for: a) statistical processing and data analysis (QStat) and b) predefined data analysis. In the specific case study, tools for predefined data analysis are specially specialized for the innovative process of analysis, collection and reception of raw milk. These tools are implemented as a module within the business application QProMng, with sufficient flexibility to enable access and analysis of all existing databases, which are available as a resource to the specific dairy.

Therefore, the mentioned tools for analysis in cooperation with the applied ED paradigm, enable management and employees to, based on the data on the events to which they are subscribed:

- monitor the innovated process,
- react in a timely manner to potential problems in the process and
- undertake activities aimed at further optimization, improvement and process innovation.

3.3 Analysis of the impact of the implementation of QDMS

In this part of the paper, an overview of the results achieved by applying the author's developed methodology in concretely realized case studies of process innovation is given.

Bearing in mind that the target group of the research is manufacturing SMEs, in the analysis of the impact of QDMS implementation on process innovation and improving the level of business excellence, experience gained during the implementation of originally developed software solutions was used both in the area of document management and in the area of business process innovation.

More specifically, the analysis used data from 4 projects (4 case studies) of the introduction of specially developed software solutions to support process innovation in four production organizations that belong to small and medium-sized enterprises (SMEs). The aforementioned innovation projects engaged approximately the same resources during implementation. The observed companies have introduced the ISO 9001 system, and accordingly some form of documentation management. The companies were chosen so that the impact of the implementation and exploitation of the developed QDMS on the management of the innovation process can be seen.

The results of the conducted research are presented through originally developed programs for statistical data processing as well as for the assessment of achieved business excellence. In this way, the practical application of the developed methodology was shown, as well as its impact on the change in innovation potential and business excellence of SMEs.

Multi-criteria analysis using the SAW method. SAW (Simple Additive Weighting) is a relatively simple and the most used method of multi-criteria analysis [17]. The method is based on a weighted average. The advantage of this method is that it performs a proportional linear transformation of the raw data, which means that the relative order of magnitude of the total normalized result is equal and directly comparable even after the transformation.

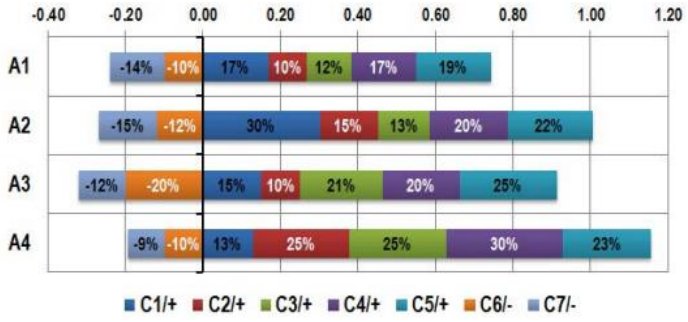
Using the SAW method, the analysis results are determined by adding weight values for each selected criterion. The method consists of three steps: a) rating normalization in order to achieve mutual comparability; b) application of criteria weight values to normalized ratings; and c) summing up the values of indicators for alternatives. The following formula gives the general form of the multi-criteria analysis model in a matrix display:

$$R = \begin{array}{c} \\ w \\ A_1 \\ A_2 \\ \vdots \\ A_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_m \end{array} \\ \begin{array}{cccc} w_1 & w_2 & \cdots & w_m \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \end{array} \quad (4)$$

Where:

- R – the achieved result of an individual alternative,
- An – alternative, i.e. the observed aspects,
- Cm – criteria, indicators of the value of the dimensions of individual aspects,
- wm – weighting coefficients for each selected criterion,
- xij – values of the corresponding criterion, for each aspect of observation.

Figure 1. Graphic representation of the multi-criteria analysis of the impact of QDMS on process innovation



The obtained results (Figure 1) show that the implementation of some form of software-supported QDMS in the observed companies has positive effects on the implementation of process innovation. The most pronounced positive effects are experienced by companies that implement the most extensive extensions of the QDMS domain (in this case it is company P4, that is, in this analysis, alternative A4).

3.4 Analysis of self-assessment of excellence according to the EFQM 2013 methodology

Self-assessment is a systematic and regular review of the company's activities and the results achieved according to the model of excellence. Self-assessment is a positive way of recording the current situation and allocating constructive efforts for priority solutions with the aim of continuous improvement as well as innovation, their way of measurement to determine positive changes with long-term results.

The fact is that the self-assessment method requires a multidisciplinary approach with constant and systematic reviews of process activities, constant improvements and innovations:

- Determining the state of what we have done?
- Determining the current state that leads us to new changes with innovative activities
- Determining the relationship between what we do and what we want to do.

In order to carry out self-assessment according to the EFQM 2013 methodology, an analysis of current questionnaires (EFQM Model in Action, n.d.) was performed according to all nine criteria, and based on that, the author's database model and application solution for self-assessment were modified and developed. The application solution enables the installation of

the program on the company's computers and thus the continuous process of self-assessment according to this methodology. In this way, the conditions for assessing the current position of the company and identifying its key strengths and areas of improvement are created. The following formula gives the mathematical form of the model for self-assessment:

$$R = \sum_{9}^{K=1} \sum_{m}^{S_K=1} S_K \cdot G \cdot \frac{W_K}{m} \qquad (5)$$

Where are:

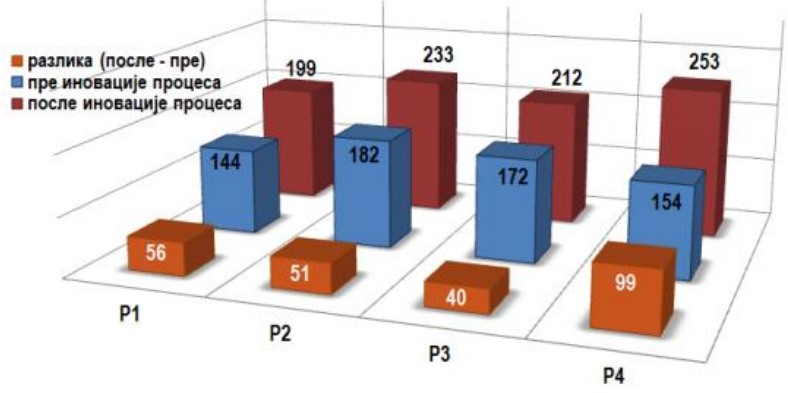
- K - main criteria of the method (from K1 to K9),
- SK - sub-criteria of each of the main criteria (from S1 to minimum S7 and maximum S9)
- WK - weighting coefficients for each of the main criteria (from W1 to W9 with values of 0.1 or 0.15),
- G - score of the subcriteria (from 0 to 4 where 0 brings 0%; 1 brings 25%; 2 brings 50%; 3 brings 75%; and 4 brings 100% of the points carried by the sub-criterion in accordance with the weight coefficient and the number of associated sub-criteria within the criteria).
- The database of the application solution was initially filled according to the requirements of EFQM 2013, but the users are left with the possibility of adapting and expanding the defined criteria, sub-criteria as well as the way of evaluation.

In addition to the numerical evaluation, each criterion also has descriptive comments related to a) existing advantages and b) areas of improvement of the company for the business segment to which the observed criterion refers. The program also supports the entry of these descriptive comments, but they were not taken into consideration during the analysis.

According to the defined EFQM 2013 model, evaluation is done according to each sub-criterion within each of the nine criteria. The review of results was realized with reports showing comparative results for two selected self-assessments. In this way, the progress of achieved business excellence is shown descriptively and numerically. For the purposes of analyzing the impact of QDMS on the process innovation process, the observed companies conducted a self-assessment before and after the implementation of innovative software solutions. The results are presented in graphic form a) individually by company and b) in summary.

In the case of individual radar diagrams, a comparative result before and after process innovation is given in percentage for each EFQM criterion. In the interpretation of the summary result, the value of points obtained according to the business excellence model EFQM 2013 is shown a) before the introduction of the process innovation, b) after the introduction of the process innovation and c) the achieved difference.

Figure 2. Summary results of self-evaluation according to EFQM



From the graphical interpretation of the obtained results, it is shown that the greatest relative progress of business excellence after the implementation of process innovation is shown by company P4, where QDMS was applied with the most extensive domain extension. The most even progress of business excellence was achieved at the company P2, which applies QDMS in its basic domain (QMS documentation management).

4. CONCLUSIONS

Innovations represent an important prerequisite for improving the competitiveness of small and medium-sized enterprises. It is difficult to imagine the growth and development of all, including SMEs in that context, without developed innovation activities, based on a firmly defined innovation process.

By presenting and considering the concept of TQM and business excellence, innovation was detected as the "fuel" of SME business excellence. In order for innovations to be realized, it is necessary that innovation, as a key attribute of SMEs, be woven into their business culture, vision, mission and strategies. This part of the work also initiated the creation of an original author's solution for the self-assessment of business excellence of SMEs according to the original EFQM 2013 methodology (the solution also allows the modification of metrics according to the specific needs of the organization that uses it).

In the continuation of the work, a) knowledge as a necessary resource for creating innovations, b) management of knowledge flows and c) the innovation process itself were discussed. The general conclusion is that SMEs must strive for an innovative approach to organizing, which assumes that the organization's innovative effort must encompass the entire process structure. Therefore, the organization's innovative culture and policy, as well as the ways in which they are implemented, represent the responsibility and obligation of all employees and assume their commitment to it. In order to realize this, IT infrastructure is needed as a carrier of codification, dispersion and concretization of knowledge and its focus on an efficient and effective innovation management process. QDMS (but now additionally extended to the domain of QMS draft management and functionally enriched with the paradigm of event-based management) is emerging as a sustainable and expedient solution for SMEs.

The proposed and developed model, methodology and specific proprietary software application solutions are presented in more detail in the paper through development steps, functional review and case studies of manufacturing companies.

The model was verified through analyzes conducted in four companies as four case studies of process innovation development. All the analyzed production organizations have introduced QMS according to the requirements of the ISO 9001 standard, which guarantees business according to the process approach and the existence of systematically organized business processes. One of the observed companies did not apply software-supported documentation management of QMS, while the other three companies used QDMS in basic or one of its extended forms.

At the beginning of the research of the problem, the basic hypotheses were defined and proved during the research.

Based on the defined methodology and metrics of EFQM 2013, a model for self-assessment of business excellence was developed. Based on the model, the application solution QSA (Quality Self Assessment) was developed. The solution enables the measurement of the achieved level of business excellence of the organization using the self-assessment method,

while also having flexibility; the originally applied EFQM 2013 metric can be adapted to the specific needs of an individual organization in order to apply it more effectively.

The obtained results of the analysis showed: The greatest relative progress of business excellence after the implementation of process innovation was achieved by the company where the proposed new QDMS solution was implemented with the most extensive domain extension. The company that implemented the proposed QDMS solution in its core domain (QMS documentation management) achieved the most consistent progress in business excellence after the implementation of process innovation.

The presented methodology, implementation and configuration of the proposed and developed new application solutions for managing the innovation process are flexible; practice shows that they can be successfully applied within the existing QMS and IT systems of manufacturing small and medium enterprises. In any case, the developed methodology, model and application solution, due to their topicality, provide a great opportunity for further improvements in a large number of different directions.

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